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WOOD CHARCOAL IN CALIFORNIA

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KEITH ARNOLD, DIRECTOR

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ACKNOWLEDGMENTS

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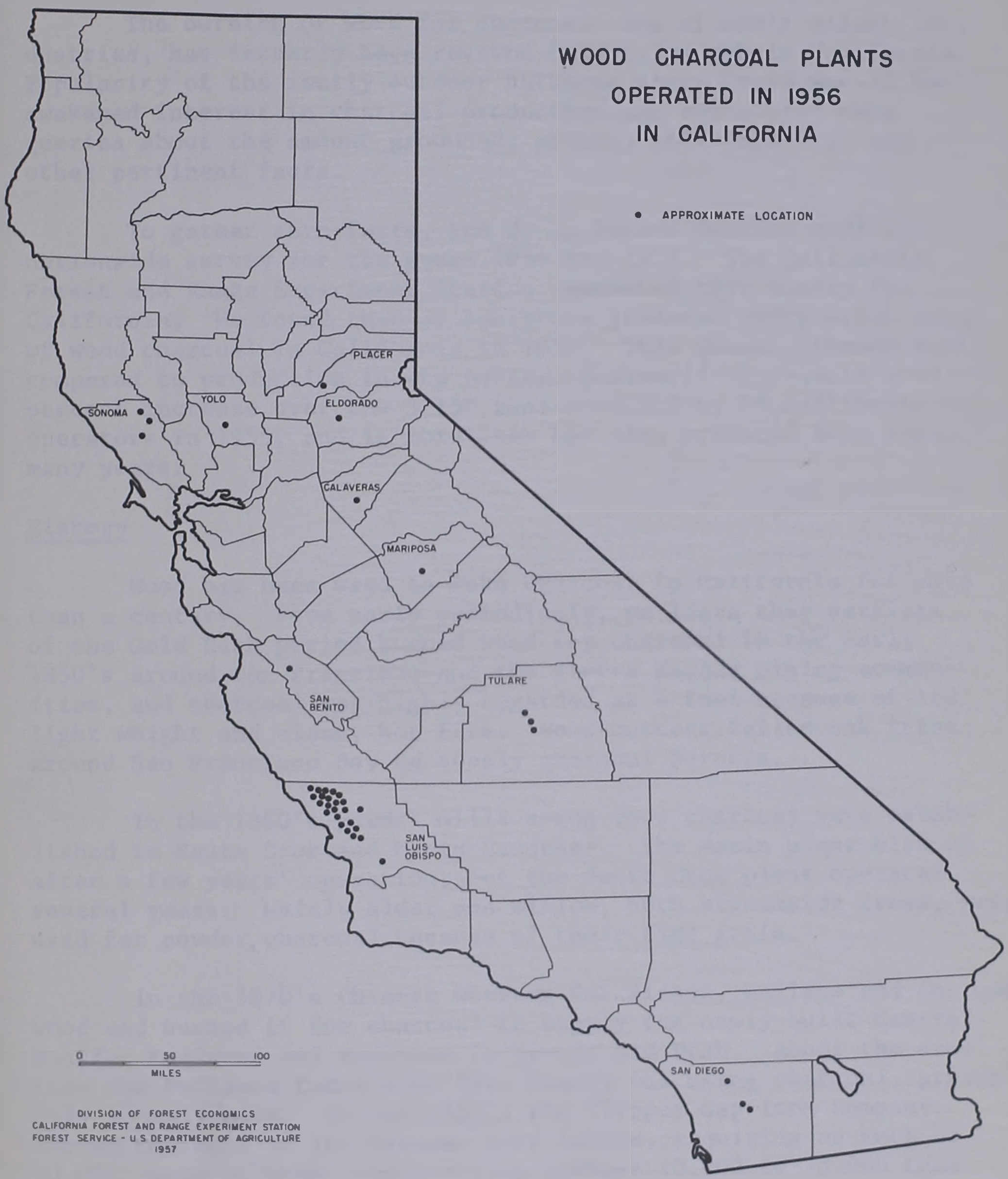
NOTE

Anyone wishing information on charcoal kiln design or construction may obtain it by writing to the Director of this Station, P.O. Box 245, Berkeley 1, California; or to the U. S. Forest Products Laboratory, Madison 5, Wisconsin.

The California Forest and Range Experiment Station is maintained at Berkeley, California, in cooperation with the University of California.

Agriculture--Forest Service, Berkeley, Calif.

WOOD CHARCOAL PLANTS OPERATED IN 1956 IN CALIFORNIA



• APPROXIMATE LOCATION

DIVISION OF FOREST ECONOMICS
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE - U S DEPARTMENT OF AGRICULTURE
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WOOD CHARCOAL IN CALIFORNIA

Richard H. May
Division of Forest Economics

The burning of wood for charcoal, one of man's oldest industries, has recently been revived from a low ebb in California. Popularity of the family outdoor barbecue since World War II has awakened interest in charcoal production and stimulated many queries about the amount produced, prices, kiln capacity, and other pertinent facts.

To gather such facts, the U. S. Forest Service made a nationwide survey for the years 1956 and 1955. The California Forest and Range Experiment Station conducted this survey in California. We found that 39 operators produced about 4,650 tons of wood charcoal in California in 1956. This amount, though small compared to production in the eastern States,[1/] represents a 48 percent increase over the 3,150 tons produced by 28 California operators in 1955, and is more than has been produced here for many years.

History

Wood has been used to make charcoal in California for more than a century. From early periodicals, we learn that settlers of the Gold Rush period burned wood for charcoal in the early 1850's around San Francisco and the Sierra Nevada mining communities, and charcoal was highly regarded as a fuel because of its light weight and clean, hot fire. Wood-cutters felled oak trees around San Francisco Bay to supply charcoal burners.

In the 1860's powder mills using wood charcoal were established in Santa Cruz and Marin Counties. The Marin plant blew up after a few years' operation, but the Santa Cruz plant operated several years. Mainly alder and willow, both streamside trees, were used for powder charcoal because of their fine grain.

In the 1870's Chinese working for Sisson, Wallace and Co. cut wood and burned it for charcoal to supply the newly-built Central Pacific Railroad and smelters in Nevada and Utah. About the same time the Defiance furnace in Inyo County was using charcoal, presumably locally made. In the 1880's the Clipper Gap Iron Company burned charcoal in its furnace near Auburn, requiring as much as 30,000 cords of wood--representing perhaps 10,000 to 15,000 tons of charcoal a year.

1/ The 1956 Forest Service survey shows a total U.S. charcoal production of almost 265,000 tons--98 percent of it in the eastern States.

For the period 1905 to 1910, the California State Agricultural Society published statistics on charcoal production by sacks for various counties. Sonoma County appears to have been a top producer then, with about 100,000 sacks annually. Assuming 20 pounds per sack, Sonoma production ran about 1,000 tons per year.

So far as is known, all charcoal was produced in pits or kilns until 1910. About this time the Noble Electric Steel Company established a steel plant at Heroult on the Pit River--a site now under Shasta Lake. They needed charcoal and planned to make it by distillation of pine wood at the rate of 50 cords per day. Apparently this operation was not successful, for in 1914 the company was experimenting with oak instead of pine.

In the 1920's and 1930's, according to U. S. Bureau of the Census reports, wood distillation and charcoal manufacture accounted for 2 to 3 establishments with a product valued at $5,000 and more. Charcoal dealers of the period put California's charcoal requirements at 3,000 tons in the 1920's and 6,000 tons in the 1930's. The demand not met by local production was supplied by other states and foreign countries. Domestic, restaurant, and hotel use took 80 percent of the total; the rest went into poultry feed and chemical processes. Kilns were operated in San Luis Obispo County and one in Mendocino County, using largely local oaks.

Census figures show that 142,000 bushels (1,420 tons) of lump charcoal valued at $42,000 (about $30 per ton) were produced in California in 1939. By 1947 California had no charcoal plants with a product value exceeding $5,000; only a few small kilns operated in San Luis Obispo County.

Within 10 years, however, 39 operators were active. Of 27 who reported the year of their first operation, 9 started in 1956; another 9 in 1954 or 1955, and the remaining 9 in earlier years (table 4). Only one of the last group started before World War II, and it began operation in 1925. This old-timer is in San Luis Obispo County.

Production in 1956

San Luis Obispo County is the center of California's wood charcoal industry. It accounted for 79 percent of the 4,650 tons produced in 1956, and 87 percent of 3,150 tons in 1955. The north Sierra group of counties (Calaveras, El Dorado, Mariposa, Placer) accounted for 11 percent of the State's 1956 production. Plants in five other counties produced the remaining 10 percent (table 1).

Lump charcoal comprised 85 percent of total State production in 1956 (table 2). Lump size consists of those pieces which will

not pass through a 3/4-inch mesh screen. Lump charcoal is burned as such, or may be further crushed for briquetting or for use in the chemical and metallurgical industries. Most of the "fines" (under 3/4 inch) are used for briquetting or industrial use. Some operators reported no fines, probably because they did not recover this class of material.

Production by Size of Operation

Almost a third of the total 1956 output was produced by the four largest plants (those producing 200 to 499 tons a year). The 18 medium-sized plants accounted for almost half of the total. The 11 smallest plants (1 to 49 tons) produced but a small share of the total. Six plants whose production was estimated and their size class unknown, accounted for the remaining 17 percent (table 2). San Luis Obispo County contains most of the larger plants: 3 of the largest and 13 of the medium-sized ones, but only 3 of the 11 small plants reporting.

Number, Kind, and Capacity of Kilns

The number of kilns per operator ranged from 1 to 11 in California in 1956. The kilns varied in capacity from 1 to 27 cords per charge. The cycle for burning ran from 2 days to 30 days, this time including loading and unloading as well as coaling. This information and the kinds of kilns were reported by 34 operators in 1956. Altogether, they had 109 kilns with a total capacity of 1,131 cords (table 3). If the operators not reporting had the same average number of kilns, 134 kilns were operated in California during 1956, with a total capacity of about 1,390 cords.

Of the reporting operators, more than half had kilns of concrete or cinder block or of reinforced concrete. The rest were fairly evenly distributed among steel, brick, and other types. Other types include: rock masonry, rock and clay, adobe, steel top with earth sides, and even the time-honored "pits" in which the wood is burned with a covering of earth and straw or leaves. The concrete and cinder block kilns averaged 11 cords capacity, the steel and brick kilns each about 7, and the other types almost 14 cords. Average capacity per kiln for all reporting kilns in the State is 10.4 cords.

Wood Species Burned

Practically all--99 percent--of the wood burned was oak. Precisely which oak species were used was not reported, but it is known from general observation, and from the distribution of the various oaks, that coast live oak (*Quercus agrifolia* Nee) is most commonly used in San Luis Obispo County; Oregon white oak (*Q. garryana* Dougl.)

in Sonoma and Yolo Counties; and blue oak (Q. douglasii Hook. & Arn.) and, to lesser extent, California black oak (Q. kelloggii Newb.) in the Sierra Nevada foothills. A small amount of Pacific madrone (Arbutus menziesii Rorsh.) was used in Sonoma County. Almost all the wood was round, or split from round wood. No softwoods were reported burned for charcoal in 1955 or 1956.

About 9,180 cords of wood were consumed in 1956--very close to 2 cords of wood per ton of charcoal. San Luis Obispo operators came under the state average, getting 1 ton of charcoal for each 1.8 cords of wood (table 5). Whether this is due to the greater experience of these operators, or to the greater density of coast live oak is not known.

One operator brought the north Sierra group's average up to 3.05 cords per ton. Either this operation is unusual or the reported figures are in error.

Cost of Wood

Wood purchased for coaling in 1956 cost $12.11 per cord delivered at the plant, on the average (table 6). This figure is based on 3,623 cords bought by 14 operators and including about 40 percent of total consumption. Another 14 operators cut their own wood or got it on shares for clearing land, and assigned no value for labor. Source of wood for the other 11 operators is unknown.

Cordwood prices ranged from $7.50 to $15.00 in the State as a whole, with the maximum of $15.00 occurring in all areas. But the minimum price was $9.00 to $10.00 in coastal counties against $7.50 in the Sierra Nevada.

Price Received for Lump Charcoal

Prices received for lump charcoal averaged $57.55 per ton in bulk, with a range from $45 to $100 per ton (table 7). The price in bags averaged $101.95 per ton and ranged from $60 to $140. Prices in San Luis Obispo County were lower than the State average, presumably because of the greater competition there.

Outlets for Charcoal

Jobbers bought about two-thirds of the wood charcoal produced in California in 1956, briquet plants took a little under one-third, and the rest (7 percent) was sold to industries, restaurants, and individual users (table 8). None of California's wood charcoal producers does his own briquetting. In San Luis Obispo County, practically all (99 percent) of the charcoal went to jobbers and briquetting plants; in the other counties, 78 percent.

Consumption of Charcoal

Figures on the total consumption of charcoal in California were not collected by the Station and are not available from any known source. It appears that consumption is several times as great as production. The difference is made up by charcoal brought from outside the State. Much charcoal is imported or produced from material other than wood. Most of the outside charcoal comes from the Eastern States and some from foreign countries, particularly Mexico. In 1956 foreign imports amounted to 3,516 tons of wood charcoal; 71 percent came from Mexico and most of the rest from Japan, with Denmark supplying less than 1 percent. In earlier years California imported smaller amounts of charcoal, and Mexico supplied an even greater proportion (table 9).

Other Sources of Charcoal

Fruit pits and nut shells are also sources of charcoal for barbecue and industrial use. The present survey, however, was confined to wood charcoal. Production from sources other than wood may nearly equal the volume of wood charcoal produced.

PROCEDURE

The California Forest and Range Experiment Station conducted this survey of wood charcoal production in California as part of a nationwide survey directed by the U. S. Forest Service.

A list of operating plants was assembled by the Station Division of Forest Economics with the help of the California Division of Forestry, and the Extension Forester.

Questionnaires were mailed to all names on the list. Second and, in some cases, third requests were sent to operators who did not respond to the first request. Some operators who did not respond to any mail request were visited in the field.

Complete returns were obtained from all northern California operators. But in southern California, including San Luis Obispo County, it was not possible to get complete returns in the time and with the manpower available. Estimates for non-reporting operators were based on data from reporting operators compiled by punch-card machines.

Producers' replies were obtained as follows:

Method:	Number of operators	1956 production
Reply by mail	23	2,440 tons
Field contact with operator	3	281 "
Field contact with jobber	7	1,140 "
No reply or contact (production estimated)	6	788 "
	39	4,649 "

Accuracy

Production estimates are subject to errors in reporting, to errors of sampling non-respondent plants, and errors of calculation. Errors in reporting were reduced by mail and field follow-up on questionable points. The chances of calculation errors are slight because of mathematical checking of all calculations.

Sampling error is measured by variation in the production of sample plants and is expressed as a percentage of total production. The calculated sampling error at one standard deviation is 6.2 percent for charcoal production in the State, and 7.7 percent for San Luis Obispo County. In the counties or county groups where all plants responded there is no sampling error. In measuring sampling error, the reports obtained by field contact with jobbers were considered as valid replies.

Table 1.- Wood charcoal produced, by county, California, 1955 and 1956

County	1956 production					1955 production		
	Plants	Lump	Fine	Total	Percent	Plants	Total	Percent
	No.	---- Tons -----				No.	Tons	
Coast counties								
San Luis Obispo	24	3,197	483	3,680	79.1	19	2,742	87.1
Sonoma-Yolo 1/	4	178	39	217	4.7	1)		
San Diego-San Benito 1/	4	105	12	117	2.5	3)	192	6.1
Subtotal Coast	32	3,480	534	4,014	86.3	23	2,934	93.2
Sierra counties								
Calaveras-El Dorado-Mariposa-Placer 1/	4	369	152	521	11.2	3)	213	6.8
Tulare	3	109	5	114	2.5	2)		
Subtotal Sierra	7	478	157	635	13.7	5	213	6.8
Total State	39	3,958	691	4,649	100.0	28	3,147	100.0

1/ Combined to avoid disclosure of individual plant figures.

Table 2.- Number of wood charcoal plants, by county and production size-class, and production by size-class; California, 1956

County	1 - 49 tons	50 - 199 tons	200 - 499 tons	Unknown 1/	All classes
	NUMBER OF PLANTS				
Coast counties					
San Luis Obispo	3	13	3	5	24
Sonoma-Yolo	2	2	0	0	4
San Diego-San Benito	2	1	-	1	4
Subtotal Coast	7	16	3	6	32
Sierra Counties					
Calaveras-El Dorado-Mariposa-Placer	2	1	1	0	4
Tulare	2	1	0	0	3
Subtotal Sierra	4	2	1	0	7
Total State	11	18	4	6	39
	PRODUCTION IN TONS				
Size of particle					
Lump	163	2,008	1,130	657	3,958
Fine	18	285	257	131	691
Total	181	2,293	1,387	788	4,649
Percent of total	4	49	30	17	100

1/ Production estimated.

Table 3.- Kind, number, capacity and burning cycle of wood charcoal kilns in California, 1956 1/

Kind of kiln	Unit	Coastal counties: San Luis Obispo	Coastal counties: Sonoma-Yolo-San Diego	Sierra counties 2/	State total	Average capacity
						Cords per kiln
Concrete or cinder block 3/						
Kilns	No.	42	7	14	63	
Total capacity	Cords	557	121	34	712	11.3
Average cycle	Days	18.4	24.6	4.6	16.0	
Steel oven or tank 4/						
Kilns	No.	4	14	0	18	
Total capacity	Cords	12	106	-	118	6.6
Average cycle	Days	14.0	11.6	-	12.1	
Brick						
Kilns	No.	0	0	12	12	
Total capacity	Cords	-	-	84	84	7.0
Average cycle	Days	-	-	5.0	5.0	
Other (Rock, Adobe, Pits)						
Kilns	No.	16	0	0	16	
Total capacity	Cords	217	-	-	217	13.6
Average cycle	Days	19.6	-	-	19.6	
All kinds						
Kilns	No.	62	21	26	109	
Total capacity	Cords	786	227	118	1,131	10.4
Average cycle	Days	18.4	15.9	4.7	14.7	
Plants reporting		21	6	7	34	

1/ Reporting kilns only (includes 1 plant active in 1955, but idle in 1956.)
2/ Calaveras, El Dorado, Mariposa, Placer, Tulare.
3/ Includes reinforced concrete.
4/ Square or cylindrical, but not beehive type.

Table 4.- Age of California wood charcoal plants active in 1956, by county

Year operation started[1/]	San Luis Obispo	Other coast counties[2/]	Sierra counties[3/]	State total
	---------- Number of plants ----------			
Pre-1940	1	-	0	1
1947-1948	2	-	0	2
1950	-	1	1	2
1951	1	-	0	1
1952	2	1	0	3
1954	2	1	1	4
1955	2	-	3	5
1956	3	4	2	9
Unknown	11	1	0	[4/] 12
Total	24	8	7	39

1/ Non reported starting in 1949 or 1953.
2/ San Benito, San Diego, Sonoma, Yolo.
3/ Calaveras, El Dorado, Mariposa, Placer, Tulare.
4/ It is estimated that 4 of these were new in 1956.

Table 5.- Wood burned by charcoal producers, by species and county, California, 1956

County	Species of wood: Oak	Madrone	Total	Charcoal produced	Ratio: wood to charcoal
	------ Cords ------			Tons	Cords/ton
Coast counties					
San Luis Obispo	6,648	0	6,648	3,680	1.80
Sonoma-Yolo	358	128	486	217	2.24
San Benito-San Diego	223	0	223	117	1.91
Subtotal Coast	7,229	128	7,357	4,014	1.83
Sierra counties					
Calaveras-El Dorado-Mariposa-Placer	1,595	0	1,595	521	3.05
Tulare	229	0	229	114	2.01
Subtotal Sierra	1,824	0	1,824	635	2.87
Total State	9,053	128	9,181	4,649	1.97

Table 6.- Volume and cost of wood purchased for charcoal burning, California, 1956

County	Plants reporting	Volume purchased	Total price	Cost per cord	Range in price per cord
	No.	Cords	--------- Dollars ---------		
San Luis Obispo	5	2,284	28,798	12.61	9.00 - 15.00
Sonoma-Yolo-San Diego	5	575	7,270	12.64	10.00 - 15.00
Calaveras, Placer-Tulare	4	764	7,802	10.21	7.50 - 15.00
Total State	14	3,623	43,870	12.11	7.50 - 15.00

Table 7.- Prices per ton for lump charcoal, in bulk and in bags, received by California producers, 1956

County	Plants	Volume	Range	Weighted average
	IN BULK			
	No.	Tons	---- Dollars -----	
San Luis Obispo	17	2,032	45 - 60	54.35
Other coast counties 1/	4	122	60 - 85	79.20
Sierra counties 2/	3	121	80 -100	89.75
Total State	24	2,275	45 -100	57.55
	IN BAGS			
San Luis Obispo	3	470	60 - 90	85.70
Other coast counties	4	103	70 -135	119.55
Sierra counties	5	314	100 -140	117.20
Total State	12	887	60 -140	101.95

1/ San Benito, San Diego, Sonoma, Yolo.
2/ Calaveras, El Dorado, Mariposa, Placer, Tulare.

Table 8.- Reported outlets for wood charcoal marketed by California producers, 1956

County	Jobbers	Briquet plants	Industrial	Other 1/	All outlets	Volume reported
	Percent					Tons
San Luis Obispo	68	31	1	0	100	2,735
Other counties	56	22	2	20	100	861
State average	64	29	2	5	100	3,596

1/ Includes sales to restaurants and nurseries, and for home use.

Table 9.- Imports of wood charcoal for consumption, California 1951-1956

Year	Total imports	Imports from Mexico	
		Quantity	Percent of total
	Tons	Tons	
1/ 1956	3,516	2,512	71
1955	378	346	91
1954	1,526	1,472	96
1953	188	182	97
1952	1,261	1,261	100
1951	720	720	100

1/ In 1956, 998 tons were imported from Japan.

Source: U. S. Dept. of Commerce, Custom House, San Francisco.